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Effect of Hospital–SNF Referral Linkages on Rehospitalization

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Objective. To determine whether the rate of rehospitalization is lower among patients discharged to skilled nursing facilities (SNFs) with which a hospital has a strong linkage.

Data Sources/Collection. We used national Medicare enrollment, claims, and the Minimum Data Set to examine 2.8 million newly discharged patients to 15,063 SNFs from 2,477 general hospitals between 2004 and 2006.

Study Design. We examined the relationship between the proportion of discharges from a hospital and alternative SNFs on the rehospitalization of patients treated by that hospital–SNF pair using an instrumental variable approach. We used distances to alternative SNFs from residence of the patients of the originating hospital as the instrument.

Principal Findings. Our estimates suggest that if the proportion of a hospital's discharges to an SNF was to increase by 10 percentage points, the likelihood of patients treated by that hospital–SNF pair to be rehospitalized within 30 days would decline by 1.2 percentage points, largely driven by fewer rehospitalizations within a week of hospital discharge.

Conclusions. Stronger hospital–SNF linkages, independent of hospital ownership, were found to reduce rehospitalization rates. As hospitals are held accountable for patients' outcomes postdischarge under the Affordable Care Act, hospitals may steer their patients preferentially to fewer SNFs.

Key Words. Health economics, instrumental variables, health care organizations and systems

Over the last three decades, Medicare payment policies created silos that exacerbated health care fragmentation and increased health care transitions, including rehospitalizations. A growing number of hospitalized patients are discharged to postacute care (PAC) settings while hospital length of stay continues to drop (MedPAC 2011). The Affordable Care Act (ACA) instituted numerous provisions designed to break down these payment silos and to make hospitals accountable for their patients' PAC experiences and costs, including unnecessary rehospitalizations. One consequence of these policies may be to incentivize hospitals to enhance collaboration with PAC providers. Using Medicare claims data from beneficiaries newly transferred to skilled nursing facilities (SNFs), we examine the effect of hospitals' concentrating their discharges to particular SNFs on the 30-day rehospitalization rate.

The last decade has seen a marked growth in rehospitalization of SNF patients. Between 2000 and 2006, 30-day rehospitalization rates of Medicare beneficiaries newly discharged to SNF rose from 16 to 20 percent. For prior nursing home residents, this increased from 22 to 27 percent, at an estimated total cost to Medicare of $4.34 billion in 2006 (Mor et al. 2010). The average rehospitalization rate during a Medicare-covered nursing home stay in the United States in 2006 was over 23 percent, and it has been climbing for the last decade (Saliba et al. 2000; Intrator, Zinn, and Mor 2004; Mor et al. 2010; Ouslander et al. 2010). Rehospitalizations are a symptom of dysfunction in the continuity of care, but we know little about the interorganizational structures that facilitate or complicate transitions between care settings (Feng et al. 2011a). Although there have been several randomized trials of interventions to reduce rehospitalizations among Medicare beneficiaries discharged home, no similarly rigorous studies of programs designed to reduce rehospitalization from PAC providers have been undertaken (Naylor et al. 1999; Coleman et al. 2006; Jack et al. 2009).

Policy changes under the ACA, particularly the rehospitalization penalty which went into effect in 2012, have altered the landscape to the point that hospitals must now consider the clinical capabilities of the settings to which they discharge their patients (Mor and Besdine 2011). However, while hospitals have successfully extended their domain to cover outpatient care and to create "systems" that include physician practice associations, unless a hospital owns an SNF, partnering with one is less common. Nonetheless, it stands to reason that more frequent exchanges between hospital and SNF clinical staff could improve the efficiency and effectiveness of communication. One

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would assume that frequent referrals reinforce mutual learning, making it possible for hospital–SNF pairs to experience the benefits of a positive volume–outcome relationship. With repetition, easier communication at the administrative and clinical levels is routinized and personal relations overlay and reinforce administrative arrangements.

We do know that closures of hospital-based SNFs in the last decade contributed to rising rehospitalization rates, suggesting that stronger organizational ties may be beneficial (Rahman, Zinn, and Mor 2013). In this study, we seek to determine the effect of hospitals concentrating their SNF discharges to a small number of providers on the risk that their discharged Medicare patients will be rehospitalized. We seek to test the impact of this "preferred provider" relationship with an SNF by estimating the impact of referral volume and concentration on the rate of rehospitalization. Our approach is based on the premise that the distance preference of patients acts as an important determinant of transfers from hospital to alternative SNFs. This allows us to identify portions of such transfers that are not due to unobserved quality of care or interorganizational arrangements, making it possible to estimate the net effect of hospital concentration of Medicare discharges on rehospitalizations.

METHODS

Data and Study Population

We linked three different individual-level datasets: the Medicare enrollment file, Medicare Part A claims, and the nursing home Resident Assessment Instrument Minimum Data Set (MDS). In addition, we used the On-line Survey & Certification Automated Record (OSCAR) data to capture SNF characteristics, and the 2005 American Hospital Association Survey data for hospital characteristics and zip code-level census aggregates for the year 2000.

Applying the Residential History File methodology (Intrator et al. 2011), which concatenates MDS assessment and Medicare claims into individual beneficiary trajectories, we identified all Medicare fee-for-service (FFS) beneficiaries who were discharged directly from an acute general hospital to a SNF for postacute care between January 1, 2004 and December 31, 2006. We excluded prior nursing home residents because they would be frailer than PAC patients from the community and because prior nursing home residence would systematically affect the next PAC choice. We found 3.4 million individuals who were discharged from hospital to nursing home for SNF care during the study period who met the "no prior nursing home stay" criterion. We dropped 13 percent of the individuals who did not reside in the 48 contiguous states, were not discharged from an acute general hospital, or were missing relevant hospital, nursing home, and/or residential zip code information. Finally, we dropped 7 percent of the individuals who were treated in hospitals that had fewer than 200 discharges to SNF during these 3 years. Our final sample consisted of about 2.8 million Medicare FFS beneficiaries discharged from 2,477 hospitals to 15,063 SNFs.

Outcome Variables

Our main outcome variable is 30-day rehospitalization, defined as whether the patient was readmitted to a hospital within 30 days of hospital discharge to an SNF. To better understand the effect of hospital–SNF linkage on rehospitalizations and following recent work on the topic (Rahman, Zinn, and Mor 2013), we created rehospitalization measures for three mutually exclusive periods; 1–3 days, suggesting premature discharge, or inappropriate placement; 4–7 days, a possible sign of poor communication of clinical or treatment information between the hospital and SNF; and 8–30 days, potentially indicating that SNF treatment and/or resources were inadequate to prevent a complication requiring acute hospital level of care.

Main Explanatory Variable

The main explanatory variable is the hospital–SNF referral linkage, defined as the proportion of patients from the originating hospital who were discharged to the treating SNF. By construction, it varies by hospital–SNF pair.

Control Variables

We used four types of control variables: patient characteristics, SNF characteristics, patient characteristics that vary by SNF, and hospital characteristics that vary with SNFs.

Patient Characteristics: We obtained age, gender, race, and residential zip code from the Medicare enrollment file. We used five zip code–level variables obtained from 2000 U.S. Census to characterize the neighborhood where patients lived: per capita income, poverty rate among the Medicare population, percentage of black among the Medicare population, percentage of the population living in rural areas, and population density (population per square mile area). Clinical variables recorded during the hospital stay include the Elixhauser et al. (1998) and Deyo, Cherkin, and Ciol (1992) comorbidity indices, hospital length of stay, and intensive care unit (ICU) use. Clinical variables derived from the admission MDS include selected diagnostic indicators, the number of medications taken in the last 7 days, activities of daily living (Morris, Fries, and Morris 1999), a cognitive performance scale (Morris et al. 1994), and the resource utilization group-based nursing home case mix index (5.12) (Fries and Cooney 1985; Fries et al. 1994).

SNF Characteristics: We included a series of SNF attributes from the OSCAR data that have been used as markers of SNF quality in previous studies: full-time equivalent, registered nurses, licensed practical nurses, and certified nursing assistants (Castle 2008; Castle and Anderson 2011; Hyer et al. 2011), the proportion of Medicaid paid residents (Steffen and Nystrom 1997; Carter and Porell 2003; Mor et al. 2004; Stevenson 2006), the weighted inspection deficiency score (Zinn et al. 2009; Centers for Medicare and Medicaid Services 2010; Hyer et al. 2011), occupancy rate, chain membership, and the presence of any physician extenders like nurse practitioners (Intrator, Castle, and Mor 1999). In addition, we included several facility-level aggregates of resident characteristics from the MDS (available at www.ltcfocus.org). These are the proportion of black residents, the proportion of residents enrolled in managed care, and the average resource utilization groups III case mix index.

Patient Characteristics That Vary with SNF: The only patient-level variable that varies with SNF is the distance of alternative SNFs from the centroid of patients' residential zip code. We geo-coded all the SNFs using the address on the OSCAR file and used zip code centroids as a proxy for individuals' residential location. We calculated patient to SNF distances using the Haversine formula (Sinnott 1984).

Hospital Characteristics That Vary with SNFs to Which Patients Are Discharged: We used two such characteristics. The first is the distances of alternative SNFs calculated using exact coordinates (geo-coded hospital addresses and SNF addresses as above). The second is a binary indicator that the SNF is owned by the specific hospital.

Statistical Model

Our analyses focus on the reduced form relationship of transfers (patient discharges) between a hospital and an SNF and rehospitalization of patients treated in that pair. The goal of this study is to estimate the effect of the volume of such transfers' *net* of SNF effects and hospital effects. Such a relationship is described by equation (1).

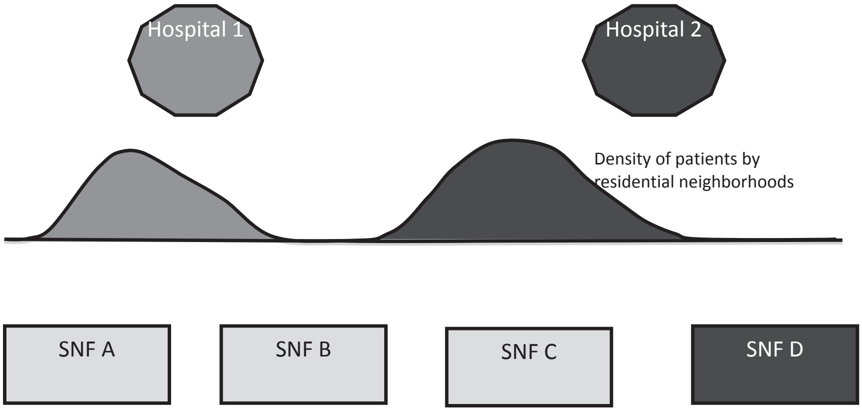
$$\begin{aligned}\mathrm{Outcome}_{ihn} = {} & \beta \mathrm{PD} + \mathrm{XI}_{ihn}\eta_1 + \mathrm{XSNF}_n\eta_2 + \eta_3 \mathrm{D\_IN}_{in} + \eta_4 \mathrm{D\_HN}_{hn} \\ & + \eta_5 \mathrm{OWN}_{hn} + \alpha_h + u_{ihn}\end{aligned} \tag{1}$$

Here, $\mathrm{Outcome}_{ihn}$ is the outcome of patient i who was discharged from hospital h to SNF n. PD_{hn} is our main explanatory variable, the proportion of patients from hospital h who were discharged to SNF n. XI_i is a vector of patient characteristics and XSNF_n is a vector of SNF characteristics. $\mathrm{D\_IN}_{in}$ and $\mathrm{D\_HN}_{hn}$ denote distance of the treating SNF from patient's residential zip code and originating hospital, respectively. OWN_{hn} is a dummy variable representing whether the SNF n is owned by hospital h or not. Finally, α_h represents hospital fixed effects. All the Greek letters except η_2 are scalars representing effects of the associated variable on rehospitalization. η_2 is a vector of parameters associated with different SNF characteristics. As the outcome variable is dichotomous, we estimate this equation as linear probability model.

The main challenge of estimating β is that PD_{hn} is likely to be endogenously determined with respect to unobservables that affect patient outcomes. That is, more transfers between a hospital and an SNF could be due to the superior quality of the SNF (as perceived by the discharged patient and her advocates) leading to an overestimate of the effect of volume on outcomes. Alternatively, higher risk patients might be systematically discharged to high-volume SNFs, leading to an underestimate of the effect of patient volume on outcomes. To disentangle this, a source of variation in transactions is needed that is not itself a consequence of the strength of the relationship or the underlying cost of coordination.

This study uses measures of proximity between the patient's home and each SNF to isolate variation in transfers which are not due to the factors that affect patients' outcome directly. We illustrate this point with Figure 1. This is a linear city-type framework where patients are *not* uniformly distributed along the street. The densities of residential location on the street of patients treated in different hospitals are shown by the same color as hospital. We assume that all the SNFs are identical except D, which is owned by Hospital 2. If only the distance between hospital and SNF matters, Hospital 1 would discharge the same fraction of patients to SNFs A and B. However, if patients' distance preferences matter, SNF A would receive more patients from Hospital 1 than SNF B as it is somewhat closer to where most patients live. On the other hand, if hospital preference matters more, patients would be discharged from

Figure 1: A Framework of Skilled Nursing Facility Choice Given Patient's Originating Hospital and Residential Neighborhood



Hospital 2 to SNF D as it is owned by and located near the hospital. Conversely, more patients from Hospital 2 would enter SNF C if only patients' distance preferences matter. Thus, if hospitals receive patients from different neighborhoods, distances of alternative SNFs from the residential neighborhood may influence the proportion of discharges (PD_{hn}). Our basic identification assumption is that the distribution of patients' distances from alternative SNFs is not correlated with unobservables that affect patients' outcomes, net of the volume of transfers attributable to hospitals' or SNFs' preference, distances of the chosen SNF from originating hospital and residential neighborhood, and other observable patient characteristics that influence the outcomes.

The main challenge of isolating patients' distance preferences from hospitals' preferences for referring to specific SNFs is how to efficiently use information on patients' relative distance to different SNFs as well as how to control for other SNF and hospital characteristics that both affect patient outcomes as well as influence patterns of SNF discharges. It is worth emphasizing that a traditional instrumental variable approach based on the relative distance of patients to nursing homes may be correlated with the relative probability of selection of a nursing home even in cases where nursing home attributes are randomly assigned. For example, if nursing homes are placed randomly along the line between a concentration of patients and the hospital, then nursing homes that are closer to the patients will be farther from the hospital, making coordination more difficult and reducing the probability that the particular home would be chosen *given* a specific patient–home distance.

We address the construction of an instrument and an appropriate control by estimating a multinomial choice model based on the random utility maximization model developed by McFadden (1974, 1978) and then decomposing the predicted allocation of patients into two components—a relative patient to SNF distance measure and a relative probability of allocation, ignoring distance. We argue, in particular, that discharge planners (acting as patient advocates but hospital employees) consider patients' placement options, rank various alternative SNFs in terms of a latent variable V_{ihn} that incorporates quality of care in that SNF (measured by a vector of SNF characteristics XSNF_{n}), the convenience to the patient (such as distance from his/her home of the placement, $\mathrm{D\_IN}_{in}$), and the coordination costs experienced by the hospital and each SNF (such as distance of SNF from hospital $\mathrm{D\_HN}_{hn}$ and whether the SNF is owned by the hospital), and picks the SNF that gets the highest ranking. This can be specified as a conditional logit model described by the following equations:

$$P_{ihn} = \exp(V_{ihn}) / \sum\nolimits_{j \in C^{i}} \exp(V_{ihn}) \tag{2}$$

where $V_{ihn} = \mathrm{XSNF}_{n}\,\delta_2 + \delta_3\,\mathrm{D\_IN}_{in} + \delta_4\,\mathrm{D\_HN}_{hn} + \delta_5\,\mathrm{OWN}_{hn}$

P_{ihn} denotes the probability that individual i enters SNF n if discharged from hospital h. Identification of the patient distance effect is possible because patients, discharged from the same hospital but coming from different neighborhoods, may have different relative probabilities of going to different SNFs.

Estimation of this discharge function requires specification of a choice set for each hospital; that is, a set of alternative SNFs where a hospital could have sent its patients. On the basis of the data, we arbitrarily defined a choice set for any hospital as the union of three sets: (1) the SNFs within a 22-km radius from the hospital (the 80th percentile of the distance traveled by all the patients to reach the SNF); (2) the nearest 15 SNFs from the hospital; and (3) all the SNFs where patients have been discharged from this hospital during our study period.

To estimate the discharge function, we expand the data such that each observation for an individual represents an SNF in his/her choice set. We create a dichotomous outcome variable, which is 1 if the observation identifies the SNF where individual i is discharged, and zero otherwise. We estimate the discharge function using the clogit command in Stata using distances and SNF attributes as independent variables, grouping per individual patient. As the estimation procedure is computationally very intensive, we used a 5 percent random sample of individuals to estimate the discharge function.

We decompose the proportion of discharges from hospital h to SNF n using alternative values of the estimated preference parameters. In particular, after estimating equation (2), we predict the probability of being discharged to different SNFs in the choice set for all the patients in our sample under two alternative cases: (1) if only the patients' distance preference mattered, that is, for $\delta_2 = \delta_4 = \delta_5 = 0$ and $\delta_3 = \delta_3$; and (2) if hospitals' preference and SNF characteristics mattered, that is, $\delta_3 = 0$,and the rest of the deltas are at their estimated values. We then aggregated the predicted probabilities by hospital–SNF pair and calculated the predicted proportion of discharges that are attributable to patients' distance preference ($\mathrm{PPD}_{hn}^{\mathrm{pat}}$) and predicted the proportion of discharges attributable to hospital and SNFs ($\mathrm{PPD}_{hn}^{\mathrm{rest}}$).

After the estimation of $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ and $\mathrm{PPD}_{hn}^{\mathrm{rest}}$, we follow the steps of conventional IV estimation, where $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ is used as an IV for PD_{hn} and $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ is used as an additional control variable. We control for $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ because, as noted, $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ and $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ may be correlated. As an additional note, we also include distances to the admitted SNF of the patient's home and the hospital ($\mathrm{D\_IN}_{in}$ and $\mathrm{D\_HN}_{hn}$). The first captures any possible health effects for the patient in question (rather than the distribution of potential patients and distances of all the SNFs in the choice set, which are captured through $\mathrm{PPD}_{hn}^{\mathrm{pat}}$). The second allows for possible effects of the hospital nursing home distance on outcomes that are not captured by $\mathrm{PPD}_{hn}^{\mathrm{rest}}$.

Sensitivity Analysis

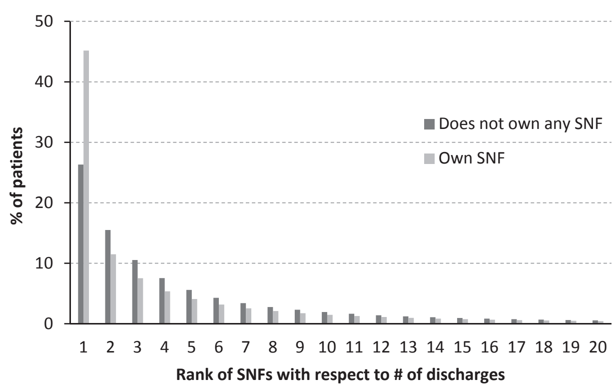
An important concern with the above specified model is $\mathrm{PPD}_{hn}^{\mathrm{pat}}$, which may reflect unobserved heterogeneity across SNFs. For example, rural SNFs can be systematically different from urban SNFs. $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ being related to population density of the residential neighborhood may reflect such unobserved difference in SNFs. To deal with this issue, we estimated two variations in our model: (1) using SNF fixed effects instead of observed SNF characteristics and (2) using residential zip code fixed effects instead of zip code characteristics from census data.

Another concern is that we focus on SNF care, ignoring the role of alternative PAC services. Patients selected for SNF care are likely to be different in markets with different availability of other PAC services. Such heterogeneity of patients may vary with hospitals' SNF ownership as well. Hospital fixed effects in our model may not capture such heterogeneities entirely. To address such differences across hospitals, we estimated $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ and $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ based on separate discharge function for each hospital (using 100 percent sample) and used them to estimate our 2SLS model. In addition, we estimated our model separately for hospitals with and without own internal rehabilitation facility (IRF), for hospitals with and without own SNF, and by hospitals of different sizes.

Results

Because discharges differ widely between hospitals with and without their own hospital-based SNFs, we performed most of our analysis separately for these two types of hospitals. Hospitals that own an SNF send about 45 percent of their patients to a single SNF compared to 26 percent in case of hospitals without a SNF (Figure 2). As presented in Table 1, for both types of hospitals, important differences exist between patients treated in the SNF that received the most patients from the originating hospital compared with SNFs to which fewer patients were discharged. The unadjusted rehospitalization rate is about 4 percentage points lower from the most preferred SNFs, especially for the

Figure 2: Percentage of Discharges from a Given Hospital to SNFs Ranked by Number of Patients Discharged from that Hospital



Note. SNF, skilled nursing facility. Ranking is based on the actual number of discharges from a hospital to alternative SNFs. Here, we presented the figures for the most preferred 20 SNFs for representative hospital.

Table 1: Mean Characteristics of Patients

Characteristics	Hospitals without SNF (1,589) Most Preferred SNF[†]	Hospitals without SNF (1,589) Rest of the SNFs	Hospitals with SNF (888) Most Preferred SNF[†]	Hospitals with SNF (888) Rest of the SNFs
No. of patient discharges	448,171	1,254,793	490,100	594,831
Outcome: Rehospitalization				
1–30 days	0.201	0.212	0.171	0.209
1–3 days	0.022	0.026	0.012	0.025
4–7 days	0.039	0.042	0.028	0.041
8–30 days	0.139	0.144	0.131	0.143
Demographics (Enrollment records)				
Age (years)	80.7	80.1	78.9	80.4
Female	0.667	0.645	0.659	0.643
Black	0.070	0.088	0.083	0.097
White	0.901	0.882	0.885	0.874
Clinical (Medicare claims)				
Length of stay (days)	8.3	10.1	7.1	10.5
Hospital reimbursement	$7,302	$8,426	$7,484	$7,806
Any ICU stay	0.315	0.350	0.326	0.344
Deyo score >2	0.206	0.219	0.209	0.228
Elixhauser score >2	0.499	0.502	0.490	0.504
% of rural population	20.1	18.6	24.8	21.3
Natural log of per capita income	23.0	23.2	21.0	21.9
Clinical (MDS)				
Morris ADL score (scale 0–28)	15.2	15.3	13.5	15.8
RUGs 5.12 nursing CMI	1.07	1.07	1.10	1.08
Diabetes mellitus	0.282	0.296	0.284	0.300
Congestive heart failure	0.221	0.219	0.203	0.227
Hip fracture	0.103	0.092	0.076	0.093
Alzheimer's	0.032	0.038	0.010	0.045
Stroke	0.134	0.148	0.095	0.160
Emphysema	0.198	0.194	0.195	0.193
Cancer	0.069	0.074	0.033	0.072
No. of meds in last 7 days	10.9	10.7	12.1	10.7
CPS, Fries/Morris 92	1.2	1.5	0.9	1.6
Neighborhood (Census 2000)				
% of rural population	20.1	18.6	24.8	21.3
Natural log of per capita income	23.0	23.2	21.0	21.9
Poverty rate (65 + age)	8.9	9.1	9.9	9.7
Population density	433.6	495.3	353.0	403.9
Fraction of black (65 + age)	0.068	0.077	0.077	0.085

[†]SNF that received highest number of patients from the originating hospital.
ADL, activities of daily living; CMI, case mix index; CPS, cognitive performance scale; ICU, intensive care unit; RUG, resource utilization group; SNF, skilled nursing facility.

Table 2: Descriptive Statistics of the Destination Skilled Nursing Facility Characteristics

	Hospitals without SNF (1,589)				*Hospitals with SNF (888)*			
	Most Preferred SNF† *(N = 448,171)* *Median*		*Rest of the SNFs (N = 1,254,793)* *Median*		*Most Preferred SNF*† *(N = 490,100)* *Median*		*Rest of the SNFs (N = 594,831)* *Median*	
Distance from hospital (km)	2.6		8.0		0.1		7.1	
Distance from patients' residence (km)	9.1		9.6		9.8		9.1	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Total no. of beds	150.4	80.5	136.3	79.3	56.5	72.5	133.7	76.7
Medicaid patients (%)	46.0	23.7	54.6	23.3	12.4	23.4	56.0	23.2
Multifacility chain (%)	0.57	0.50	0.58	0.49	0.44	0.50	0.58	0.49
For profit (%)	0.69	0.46	0.72	0.45	0.15	0.36	0.71	0.45
Any MD extender	0.36	0.48	0.37	0.48	—	—	—	—
Weighted deficiency score	62.4	61.9	64.4	65.1	35.7	39.3	62.4	65.2
% of black	7.1	11.8	9.1	14.9	8.5	12.8	10.1	16.0
% of HMO enrollees	7.4	9.6	7.9	10.4	5.8	7.8	8.2	10.7
Average RUG CMI	0.85	0.10	0.82	0.09	1.07	0.20	0.83	0.10
Total no. of FTE RN	10.3	8.5	8.6	8.4	10.5	9.2	8.0	8.2
Total no. of FTE LPN	22.0	12.8	18.4	11.3	9.3	10.0	18.2	10.8
Total no. of FTE CNA	60.4	36.0	54.3	34.6	22.3	30.2	51.8	32.6

†SNF that received highest number of patients from the originating hospital.
CMI, case mix index; CNA, certified nursing assistant; FTE, full-time equivalent; HMO, health maintenance organization; LPN, licensed practical nurse; RN, registered nurse; RUG, resource utilization group; SD, standard deviations; SNF, skilled nursing facility.

hospitals that own an SNF. However, patients discharged to less preferred SNFs have longer lengths of hospital stay, greater rates of ICU use, worse Deyo comorbidity scores, worse functional status, and higher rates of selected chronic conditions than is the case for patients discharged from hospitals to the preferred SNFs.

Facility characteristics also varied widely among the SNFs receiving a disproportionately high share of hospitals' discharges compared to the ones with fewer discharges (Table 2). SNFs that received most of the patients were located near the hospital for both types of hospitals (more than 10 km difference between preferred and nonpreferred SNFs). However, the average distance traveled from patients' residential neighborhood to the SNF is quite similar (around 1 km) for patients discharged to the preferred SNF and for patients admitted to a nonpreferred SNF. Most preferred SNFs, on average,

Table 3: Estimation of the Discharge Function Using Multinomial Logit

	(1) All†	(2) Hospitals without HB SNF‡	(3) Hospitals with HB SNF†
Distance from residential zip code	−0.0571***	−0.0593***	−0.0488***
	[−273.4]	[−278.2]	[−162.8]
Distance from hospital	−0.0551***	−0.0577***	−0.0463***
	[−265.8]	[−272.6]	[−155.9]
Own hospital-based SNF	2.412***		2.570***
	[125.6]		[118.9]
Total no. of beds	0.00120***	0.00130***	0.00145***
	[11.26]	[11.65]	[9.343]
% of Medicaid paid residents	−0.0126***	−0.0129***	−0.0119***
	[−83.87]	[−81.92]	[−53.85]
Multifacility SNF	0.135***	0.120***	0.173***
	[20.63]	[17.53]	[18.22]
For profit	0.260***	0.281***	0.204***
	[33.67]	[35.32]	[17.44]
Hospital based	−0.828***	−0.845***	−0.755***
	[−42.10]	[−36.66]	[−31.53]
Any MD extender	0.00151	0.00152	−0.00369
	[0.222]	[0.219]	[−0.352]
Deficiency score	−0.00048***	−0.00044***	−0.00056***
	[−8.780]	[−8.519]	[−6.827]
% of black residents	−0.0144***	−0.0165***	−0.0106***
	[−53.30]	[−56.93]	[−28.41]
% of HMO enrollee	−0.00539***	−0.00414***	−0.00713***
	[−13.42]	[−9.912]	[−12.42]
Average RUG CMI	0.992***	1.239***	0.730***
	[29.42]	[30.60]	[17.87]
Total no. of FTE RN	0.0108***	0.00851***	0.0128***
	[20.54]	[14.43]	[17.12]
Total no. of FTE LPN	0.0220***	0.0206***	0.0205***
	[46.54]	[42.19]	[27.66]
Total no. of FTE CNA	−0.0018***	−0.00089***	−0.00325***
	[−7.014]	[−3.363]	[−8.485]
Observations	10,447,552	9,417,828	5,193,639
No. of individuals	139,395	119,207	75,945
Pseudo R squared	0.3171	0.2794	0.3855

Note. The effects in terms of odd ratio can be calculated as exp (coefficient) − 1; the values in brackets are t-statistics.
***$p < .01$.
†Based on 5% random sample.
‡Based on 7% random sample.
CMI, case mix index; CNA, certified nursing assistant; FTE, full-time equivalent; HB, hospital based; HMO, health maintenance organization; LPN, licensed practical nurse; RN, registered nurse; RUG, resource utilization group; SNF, skilled nursing facility.

have higher nurses per bed, a lower share of Medicaid residents, and lower average state inspectors' deficiency scores. Such differences were large in the case of hospitals which own a SNF.

Table 3 presents the estimated discharge models specified by equation (2). Distance is one of the most important determinants of the SNF discharge setting. Both the distance from the originating hospital and the distance from the patients' residential neighborhood are equally important. A 1-km increase in the distance between a SNF and patients' residence, other things equal, reduces the odds of going to that SNF by about 5 percent [exp $(-0.0571) - 1$]. An additional registered nurse in a SNF increases the odds of admission by 1 percent [$\exp(-0.0108) - 1$]. As expected, patients are much more likely to be discharged to a SNF owned by the hospital.

After estimating the discharge function, we calculated the predicted proportion of discharges to each SNF separately based on distance of SNFs from patients' residential neighborhood ($\mathrm{PPD}_{hn}^{\mathrm{pat}}$) and then based on all the other variables ($\mathrm{PPD}_{hn}^{\mathrm{rest}}$). As hospitals are located near high population density areas, patients' distance preference partially reflect the preference of the hospital and thus $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ and $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ are positively correlated (Figure S1). We also compared the characteristics of the patients (Table S1) and the admitted SNF (Table S2) for patients with high and low values of $\mathrm{PPD}_{hn}^{\mathrm{pat}}$. As expected the distance from originating hospital and population density in residential zip code of the patients varies highly $\mathrm{PPD}_{hn}^{\mathrm{pat}}$. However, patients acuity measures and SNF quality indicators are fairly comparable between high and low $\mathrm{PPD}_{hn}^{\mathrm{pat}}$, especially the relatively large difference that we observed in Tables 2 and 3. Nevertheless the as found in the first stage of the 2SLS regression using $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ as an IV, both are positively correlated with the actual proportion of discharges (Table S3).

Table 4 documents the estimated relationship between the proportion of discharges from hospital to a specific SNF and the likelihood of rehospitalization of patients treated in that hospital–SNF pair. Different rows in the table represent estimates with different specifications, or with different patient subsamples. Row 1 presents the model specified by equation (1). Even after controlling for patient, SNF, and hospital characteristics, we see little relationship between rehospitalization and the proportion of a hospital's discharges to alternative destination SNFs. The results of IV regression with and without $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ as a control variable are shown in row 2 and row 3. Comparison of rows 2 and 3 points at the importance of $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ as a control variable which shows that hospitals send high-risk patients to preferred SNFs. As can be seen in Table S4, the relationship between rehospitalization and $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ is generally

Table 4: Estimated Effect of a Ten Percentage Point Increase in Proportion of Discharges from Hospital to SNF under Alternative Sample Selection Conditions

	Model	Sample/Procedure	*Rehospitalization in Different Intervals*			
			1–30 Days	*1–3 Days*	*4–7 Days*	*8–30 Days*
(1)	OLS	Entire	−0.00062 [−1.266]	−0.0011*** [−7.135]	−0.00023* [−1.687]	0.0007 [1.628]
(2)	IV without PPD_{hn}^{rest}	Entire	−0.00329*** [−5.561]	−0.00268*** [−12.06]	−0.00073** [−2.537]	0.000126 [0.243]
(3)	IV	Entire	−0.00620*** [−6.751]	−0.00431*** [−12.47]	−0.0016*** [−3.574]	−0.00029 [−0.359]
(4)	IV	Discharge function estimated separately for each hospital	−0.00832*** [−4.635]	−0.00431*** [−12.47]	−0.00160*** [−3.574]	−0.000289 [−0.359]
(5)	IV	With SNF fixed effects	−0.00960*** [−4.60]	−0.00770*** [−8.43]	−0.00248** [−2.44]	0.00059 [0.34]
(6)	IV	With residential zip code fixed effects	−0.0074*** [−3.907]	−0.0069*** [−9.752]	−0.0014 [−1.498]	0.00091 [0.546]
(7)	IV	Hospitals without SNF *N* = 1,584,128	−0.00548** [−2.385]	−0.00655*** [−7.350]	−0.00079 [−0.696]	0.00187 [0.929]
(8)	IV	Hospitals with SNF *N* = 944,857	−0.0124*** [−6.170]	−0.00495*** [−6.968]	−0.0036*** [−3.813]	−0.00379** [−2.139]
(9)	IV	Small hospitals† *N* = 1,265,274	−0.00607*** [−5.634]	−0.00368*** [−9.091]	−0.00116** [−2.223]	−0.0012 [−1.293]
(10)	IV	Large hospitals‡ *N* = 1,263,711	−0.00558*** [−3.083]	−0.00614*** [−9.006]	−0.00232*** [−2.616]	0.00288* [1.815]
(11)	IV	Hospitals without IRF *N* = 1,300,670	−0.00625*** [−5.184]	−0.00433*** [−9.543]	−0.00158*** [−2.698]	−0.000342 [−0.323]
(12)	IV	Hospitals with IRF *N* = 948,405	−0.00570*** [−2.797]	−0.00471*** [−6.189]	−0.00215** [−2.159]	0.00117 [0.652]

Note. PPD_{hn}^{rest} = predicted proportion of discharges from hospital *h* to SNF *n* with hospital and nursing home preference and zero patient's distance preference; SNF, skilled nursing facility; HB, hospital based. Each model includes patient's demographic, clinical and neighborhood characteristics, SNF characteristics, and hospital fixed effects as specified in equation (1). PPD_{hn}^{rest} is included as additional control in models [3–12]. All the regressions except 5 and 6 were run using xtivreg2 command in Stata. Robust statistics are given in brackets. Models 5 and 6 are estimated as two-way fixed effect model using twfe command in Stata.

***$p < .01$, **$p < .05$, *$p < .1$; the values in brackets are *t*-statistics.

†Hospitals with no. of discharges <1,544.

‡Hospitals with no. of discharges ≥1,544.

positive and statistically significant. Comparing row 3 with row 1, in the case of 30-day rehospitalization, the estimated effects using 2SLS are 10 times larger than the estimated effects using OLS. Taken together, these results suggest that patients at greater intrinsic risk of rehospitalization are more likely to be discharges to preferred SNFs and that this selection process implicitly undertaken by hospitals masks an overall positive effect of volume on outcomes.

On the basis of the model, we estimate that if the proportion of discharges from a hospital to a given SNF were to increase by 10 percent, 30-day rehospitalizations will decrease by about 0.6 percent. Most of this reduction in rehospitalization is due to fewer immediate bounce backs, that is, rehospitalizations within 3 days of SNF admission. Furthermore, were hospitals that do not own a SNF to concentrate their discharges as much as hospitals that do own a SNF, 1.0 percent of the 30-day rehospitalizations from these hospitals might be avoided.

These patterns are robust across different model specifications and estimations with different subsamples. Estimated effects are larger with all the alternative specifications (4–5) compared to the baseline estimation (3). On reflection, it is obvious that reducing rehospitalizations that occur almost immediately after SNF admission will raise subsequent rehospitalization rates. Eight- to 30-day rehospitalizations may principally reflect SNF quality and may not be affected by hospital-SNF linkage, especially after controlling for SNF effects.

DISCUSSION

In examining all fee-for-service Medicare beneficiaries who were newly discharged from hospital to a SNF between 2004 and 2006, we find that the greater the concentration of discharges a hospital sends to a single SNF, the lower the rate of rehospitalization, particularly in the first few days following SNF transfer. This finding applies to *both* hospitals that own an SNF and to those that do not. According to our estimate (row 3 of Table 4), if hospitals that do not own an SNF had the same distribution of discharged patients across alternative SNFs as do hospitals that own an SNF, the dominant SNF receiving more discharges would experience fewer rehospitalizations while other SNFs would experience the opposite but the net effect would be 1.0 percentage points drop in rehospitalizations from that hospital. This estimate suggests that there would have been 3,300 fewer 30-day rehospitalizations during our study period from 1,589 hospitals that do not own a SNF.

These results are consistent with earlier studies that found that areas experiencing reductions in the number of hospital-based SNFs experienced a higher than average growth in rehospitalizations throughout the first decade of the century (Mor et al. 2010; Rahman, Zinn, and Mor 2013). Clinical staff in hospitals that own an SNF are presumed to have closer working relationships that might facilitate easier communication, adoption of common clinical protocols, and even information sharing that might reduce some of the errors that are associated with inadequate transfers. Better communication should be associated with better outcomes. Although ownership provides one vehicle for enhanced communication, in lieu of purchasing an SNF, hospitals could establish a preferred provider relationship with an SNF, thereby creating a "virtual" hospital-based facility. Given the volatility of Medicare reimbursement levels and the complexity of managing a post-acute facility in light of regulatory costs and reimbursement rates, it is not surprising that many hospitals divested their ownership of SNFs during the 2000s (Feng et al. 2011b).

The ACA has multiple provisions designed to induce hospitals to be accountable for patients after discharge. First, as of October 1, 2012, hospitals began to be penalized if patients discharged with heart attack, heart failure, or pneumonia were rehospitalized more frequently than expected. Second, CMS introduced Accountable Care Organization (ACOs) to coordinate care for patients using services from hospitals, medical groups, and other providers (Larson et al. 2012). Given the scope of the shared savings and the rising cost of PAC services, some "pioneer" ACOs include PAC providers. Third, Medicare has provisionally identified "bundling" demonstrations to test the effect of introducing an omnibus reimbursement model spanning preacute through up to 90 days postdischarge (Dummit 2011). However, the paucity of research on the relationship between hospitals and SNFs limits our ability to understand the implications of these proposed policies (Sood et al. 2011).

The recent imposition of Medicare's rehospitalization penalty appears to be exacting a toll, particularly among hospitals unaccustomed to tracking their patients' status postdischarge. Over half of hospitals have been penalized for having a higher rate of rehospitalizations than expected (Braun et al. 2012). Unfortunately, many hospitals are not sure how to respond other than to control the discharge planning process more completely or to attempt to implement one of the various evidence-based interventions designed to ease transitions, coach patients, or actively schedule outpatient appointments (Hansen et al. 2011). However, these interventions do not promote clinical information and care plan exchanges between a hospital and SNF, something that is critical to reduce rehospitalization of the many Medicare beneficiaries discharged to SNF.

Establishing such "virtual" hospital-based SNF relationships begins with the identification of the partner from among the many choices in each market. Incorporating patient and family choice into the process is also complicated, particularly because our data suggest that distance is such a powerful determinant of SNF choice. Nonetheless, patients routinely take their physicians' advice on far less important decisions, suggesting that it is possible that patients and family members could be convinced that it is to their benefit to accept a specific referral for what constitutes an extension of their hospital care for recuperation and rehabilitation. Although the Stark laws prohibiting "self-referral" may complicate the manner in which patients are presented the relative merits of one SNF over another, the ACO rules have established exemptions to some of these restrictions.

Successful exchange is not merely improving discharge planning and managing patients' and families' expectations, but, as is the case in any effective interorganizational exchange relationship, clinicians in the trenches must have guidelines and be incentivized to implement communication and protocol sharing that reduces error. This requires commitment at senior levels of both organizations as well as ongoing interaction, communication, and exchange of information about clinical practice patterns from staff in both organizations—issues that has not been systematically studied in the health care literature (Bradley et al. 2012). It is likely that even hospitals that own their own SNF have not fully mastered all the necessary clinical exchanges necessary to reduce rehospitalization.

As with any study, there are a number of limitations that could bear on our conclusions. We recognize that this analysis conditions on discharge to an SNF. Depending on the market and the available supply of alternative PAC services, a certain fraction of patients are discharged to IRF and home with home health agency (HHA) services. Although we found the same estimated effects for hospitals with and without their own IRF unit, we could account for penetration of IRF or HHA in the market. Our data are from 2004 to 2006, and we are fully aware that hospital–SNF relationships are changing rapidly. It is important to replicate this study using more recent data, particularly since the introduction of Medicare's rehospitalization penalty in 2012.

Under the ACA, hospitals are being held accountable for their patients' postdischarge outcomes. This study suggests that hospitals that concentrate discharges in particular SNFs experience lower rates of readmission. It would appear that this offers an explanation of why hospitals which own a SNF have lower rehospitalization rates. It also suggests that other hospitals might establish preferred provider relationships that function as "virtual hospital-based" facilities. Our findings suggest that hospitals that establish these kinds of relationships with local SNFs may reduce their overall rehospitalization rates and thereby best serve their patients.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.
Figure S1: Box Plot of $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ with Respect to Quintiles of $\mathrm{PPD}_{hn}^{\mathrm{rest}}$.
Table S1: Comparison of Characteristics of the SNFs for Patients with Different Values of $\mathrm{PPD}_{hn}^{\mathrm{rest}}$ in the Treating SNF.
Table S2: Comparison of Patient Characteristics with Different Values of $\mathrm{PPD}_{hn}^{\mathrm{pat}}$ in the Treating SNF.
Table S3: First Stage of the IV Regression.
Table S4: Detailed Results of Second Stage (Thirty-Day Rehospitalizations).